Directorate of Intelligence

Secret

25X1

China's Expanding Silicon Industry

25X1

A Research Paper

Secret

EA 85-10003
January 1985

Copy 438

Page Denied

Directorate of Intelligence

Secret
[redacted] 25X1

China's Expanding Silicon Industry [redacted]

25X1

A Research Paper

This paper was prepared by [redacted] Office of East Asian Analysis. Comments and queries are welcome and may be directed to the Chief, China Division, OEA, on [redacted]

25X1

25X1

Secret
EA 85-10003
January 1985

25X1

China's Expanding Silicon Industry

25X1

Summary

Information available as of 28 December 1984 was used in this report.

China has embarked on an ambitious program to expand its production of electronic-grade silicon, a key material in the manufacture of integrated circuits and other electronic components. China's silicon expansion effort will enable it to sell electronic-grade silicon in international markets, as well as increase supplies for its burgeoning domestic electronics industry.

25X1

At present, Chinese silicon production suffers from several shortcomings:
- Small-scale and inefficient production.
- Equipment shortages.
- Outdated technology.
- Quality control problems.

25X1

25X1

US equipment and technical assistance figure prominently in this effort. China seeks state-of-the-art equipment capable of producing silicon wafers suitable for use in advanced very-large-scale-integrated circuit (VLSI) manufacture. The furnaces China wants to purchase, for example, are controlled by US and COCOM export guidelines and can be sold to China only with mechanical modifications to limit the size of the silicon ingots produced.

25X1

These mechanical constraints will, in our judgment, be ineffective in limiting Chinese capabilities. We believe Chinese engineers will attempt to remove the constraints, as they successfully did in 1982 with US equipment modified to meet COCOM restrictions. Increasingly close links between research institutes and production units will probably facilitate this effort.

25X1

EA 85-10003
January 1985

25X1

Whether China meets its ambitious output targets will depend on how many of the projects announced by several different ministries and municipalities are actually undertaken, when equipment for the proposed projects is acquired, and how long it takes for Chinese factories to assimilate the imported technology. In our judgment, several factors will inhibit China's expansion plans:

- China does not have a central body responsible for overseeing silicon production, as it has for some other strategic materials and technologies, such as fiber optics.
- China's most ambitious project, accounting for half of its projected 1990 silicon production, remains poorly defined, with output targets ranging from 50 to 600 metric tons of polycrystalline silicon per year and with funding still in question.
- Problems absorbing imported technology and regulating quality control exist in the silicon industry as in other sectors of China's economy.
- Many of the projects will start slowly, with the testing of state-of-the-art equipment in Chinese research institutes to precede large-scale commercial production. 25X1

Although these problems will probably prevent output from reaching Beijing's most optimistic targets, we believe that Chinese silicon production will nonetheless increase significantly over the course of this decade. China's demand for the material will probably lag by several years, because gearing up for commercial production of integrated circuits will take more time. 25X1

We judge that excess Chinese silicon will continue to be exported primarily to customers in the United States and Japan. Expanded Chinese production will, however, also add to the supplies of silicon available to Soviet Bloc countries. 25X1

Demarches to several Chinese exporters regarding past sales of silicon to third-party brokers known to supply the Soviet Union have not prevented other Chinese trade corporations from making similar offers. Continued offers may indicate Beijing's inability to control its numerous trading corporations or, alternatively, an unawareness on the part of the exporters of which foreign customers have Soviet buyers. In our judgment, the rapid decentralization of China's foreign trade structure now under way will probably encourage the entry of additional exporters into the trade in electronic materials and further inhibit China's already limited ability to control its exports. 25X1

25X1

We believe that, for the next few years, Chinese silicon will continue to be offered occasionally to brokers who may retransfer it to Soviet Bloc countries. We judge there is little likelihood that this situation will change as long as:

- China has no central authority with responsibility for overseeing export controls.
- China's electronics industry is unable to absorb the increased silicon output.

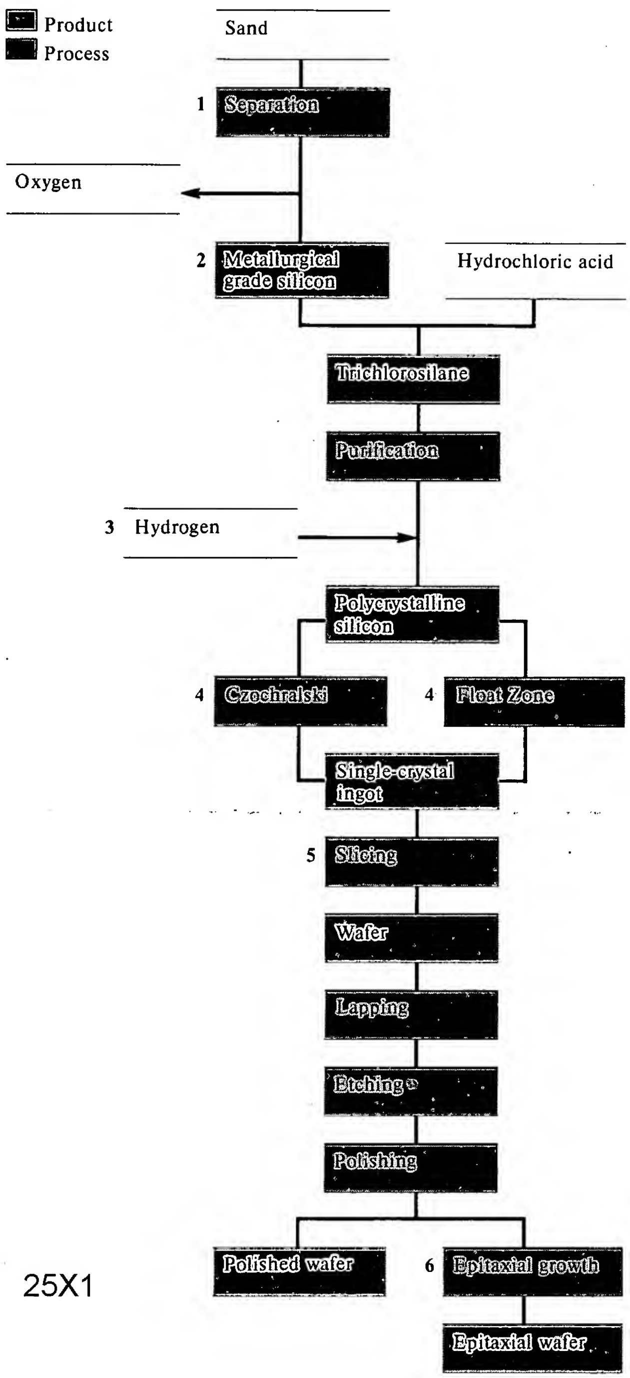
25X1

[redacted] 25X1

Contents

25X1

Figure 1
Silicon Production Process



Silicon is the basic element driving the development of today's electronics industry. In its raw form, it is one of the most abundant elements on earth–silicon dioxide or sand.

Processing sand into high-purity silicon wafers for use in electronic devices usually takes the following steps:

1 An electric arc furnace separates silicon dioxide into metallurgical grade silicon and oxygen.

2 The silicon, impure by electronics standards, is combined with hydrochloric acid to make the chemical trichlorosilane.

3 Purified trichlorosilane and hydrogen are combined in a reactor to produce high-purity polycrystalline silicon, consisting of crystals of many different orientations.[a]

4 Two processes, Czochralski (CZ) and Float Zone (FZ), can be used to convert the polycrystalline silicon, with its variety of crystal formations, to silicon with a uniform crystal orientation. Both processes involve melting the polycrystalline material, then growing a monocrystalline (single-crystal) ingot from the molten silicon.

5 The ingot is ground into a smooth cylinder, then sawed into ultra-thin wafers, the surfaces of which are lapped, etched, and polished.

6 A thin film of silicon may be grown on one side of those wafers to be used in manufacturing advanced devices. After polishing or growth of this epitaxial layer, the wafer is ready for the hundred or more steps used to fabricate transistors, resistors, integrated circuits, and other semiconductors on its surface.

[a] Improvements on the trichlorosilane process which call for using either dichlorosilane or silane gas have recently been made, but are not yet widely used.

25X1

304490 1-85

[redacted] 25X1

China's Expanding Silicon Industry [redacted]

25X1

One of Beijing's top priorities for the 1980s is the development of China's electronics industry, especially its ability to produce large-scale integrated circuits and computers. Beijing's announced goal is to produce electronic products of 1980 Western vintage by 1990, in preparation for entering the international marketplace with computers and integrated circuits by the year 2000. Progress toward this goal requires China to improve its indigenous ability to produce the principal material used in integrated circuit fabrication—silicon. [redacted]

25X1

To accommodate the increased domestic demand for silicon—and to develop a new export industry—China has begun an ambitious program to upgrade and expand its silicon industry with imported equipment and technology. China has announced plans to expand, [redacted] production of polycrystalline silicon and to boost China's ability to process this material into the wafers onto which electronic devices are fabricated. One major contract with a foreign firm has already been negotiated, and we expect China to sign additional contracts in early 1985. [redacted]

25X1

25X1

Limitations of Current Chinese Production

Many of China's polycrystalline silicon reactors and single-crystal growing furnaces date from the 1960s, when China covertly imported a turnkey silicon facility from Japan and installed it in Luoyang, Henan Province. The plant was subsequently replicated in several interior cities using a mix of East European, Japanese, and indigenously manufactured machinery. Although more recent equipment purchases have supplemented the 20-year-old technology, Chinese silicon production remains inefficient. [redacted]

25X1

China reportedly produces 200 to 250 metric tons of polycrystalline silicon annually, well below the industry's estimated maximum capacity of 300 metric tons. Annual production of single-crystal[1] ingots is estimated to be only 60 metric tons. Because of the limited information available, we cannot estimate with confidence China's annual wafer production, but we judge that quality and production problems have kept wafer output significantly below the optimum levels called for by Western and Japanese standards. Several factors account for China's underutilized capacity and low conversion rate. [redacted]

25X1

Small Factories

China has failed to take advantage of economies of scale both in producing polycrystalline silicon and in converting it to single-crystal form. China produces its polycrystalline silicon in some 20 plants, most of which are capable of processing only 5 to 15 metric tons per year. The largest plants are in Luoyang (Henan), Beijing, and Shanghai, and have a capacity ranging from 25 to 40 metric tons per year. China has as many as 30 small, inefficient, and poorly equipped monocrystalline silicon plants. The largest one produces only about 8 metric tons per year, and most produce only 1 to 2 tons annually (see appendix). In contrast, the largest producers of silicon in the non-Communist world—West Germany, the United States, and Japan—typically manufacture polycrystalline silicon in plants with a capacity of 200 metric tons or more per year. The most efficient plants are designed to produce as much as 2,000 metric tons annually. In the West monocrystalline silicon is most often produced in factories ranging upward from a minimum annual capacity of 100 metric tons. [redacted]

25X1

The relatively small size of China's silicon factories has reduced significantly the gains expected from major investments made in infrastructure, water purification, and gas recovery systems. Western observers

[1] The terms "single-crystal silicon" and "monocrystalline silicon" are used interchangeably throughout this paper. [redacted]

25X1

of China's silicon facilities have noted that, where the investment in such secondary facilities has already been made, plant capacities could be increased substantially with minimal additional investment in processing equipment. [redacted]

25X1

Bottlenecks

China lacks enough furnaces to convert all of its polycrystalline material into single-crystal ingots. By world standards, China should be able to produce 100 to 125 metric tons of single-crystal silicon instead of the 60 tons it reportedly now produces.[2] A shortage of crystal furnaces at the Luoyang Silicon Materials Plant, for example, reportedly restricted the plant's output of single-crystal material to only 8 metric tons in 1983, although the plant produced enough polycrystalline silicon to make 15 to 20 tons of ingot. An insufficient number of saws to slice wafers from the single-crystal ingots, and too few machines to prepare the wafer surfaces for device fabrication reportedly kept the Luoyang plant from processing half of its already limited output of monocrystalline ingot into wafers. [redacted]

25X1

Outdated Equipment

Even China's largest and most advanced facilities are outmoded and yield only a fraction of what modern equipment can produce. Beijing Chemical Plant Number 2, for example, requires 20 tons of trichlorosilane for each ton of polycrystalline silicon produced, about twice as much as is used in US plants. Moreover, modern Western reactors can process much larger quantities of silicon per reactor run than the best Chinese equipment. For monocrystalline silicon production, even China's more recently imported furnaces—of which there are only a handful—can grow only a fraction of what can be grown in a single modern furnace. [redacted]

25X1

Moreover, the absence of automatic controls leads to excessive variations in purity and resistivity over the length of the ingot and lowers the percentage of the ingot that can ultimately be used in wafer fabrication. As a result, a large portion of the Chinese ingot must be sold as scrap for solar cells or remelted and reprocessed into usable grade ingots. [redacted]

25X1

[2] Under normal operating conditions, 2 tons of raw electronic-grade polycrystalline silicon yields about 1 ton of monocrystalline ingot. (U)

Inconsistent Quality

[redacted]

25X1

The quality of Chinese-produced single-crystal ingots and wafers is more difficult to assess—in part because China has rarely exported them, thus limiting the material available for laboratory analysis. Among the imperfections that have been noted are a lack of uniformity in diameter, inconsistent resistivity, and high concentrations of impurities at the ends and around the circumference of the ingots. China's need to import the wafers used in its more advanced integrated circuit production—such as that done at the Jiangnan Electronic Component Works in Wuxi, Jiangsu Province—suggests that China generally is unable to produce in commercial quantities ingots of sufficient quality for use in LSI or VLSI manufacture. [redacted]

25X1

Small-Diameter Ingots

[redacted]

25X1

The relatively small diameter size of Chinese wafers does not limit the sophistication of the devices China

can produce as much as it affects the economics of integrated circuit fabrication and detracts from Chinese efforts to export such wafers abroad. Larger wafers mean lower production costs for each integrated circuit produced, and, in an industry where even slight differences in chip costs determine a producer's competitiveness, chip manufacturers generally use the largest wafers their equipment can handle.[3] [redacted]

25X1

Ambitious Expansion Plans

The push to develop China's microelectronics industry depends on less costly and more technically advanced material. To update the equipment acquired covertly from Japan in the 1960s and that which has been produced indigenously, China is turning to Western suppliers [redacted]

25X1

Evidence that Chinese trading corporations were approaching foreign suppliers for silicon processing technology and equipment surfaced in 1978. That year, a Japanese firm learned that China was seeking a plant capable of producing 100 metric tons of polycrystalline silicon a year. Although the Japanese company passed up the opportunity to provide the equipment, China purchased a turnkey facility [redacted], a year later. The equipment was set up at Beijing Chemical Plant Number 2. During its first years of operation, the Chinese improved upon the imported technology [redacted]

25X1

25X1

25X1

25X1

With the country's growing awareness of the marketplace and the recent liberalization of US export policies toward China, China has turned to US suppliers for the COCOM-controlled equipment used to process single-crystal silicon. Purchases in 1982 and 1983 were largely made on a piecemeal basis, with individual pieces of equipment being consigned to as many as a dozen different plants. A number of plants remain active in purchasing silicon processing equipment, but ad hoc improvements have given way to large-scale modernization plans. [redacted]

25X1

Three different ministries and one municipal investment commission are now attempting to set up large, modern silicon facilities of their own complete with Western equipment, know-how, and managerial techniques (see table 1). The China National Nonferrous Metals Industry Corporation (CNNC), a ministerial-rank corporation carved out of the Ministry of Metallurgical Industry (MMI) in 1983, has taken over the MMI's silicon expansion plans. Chinese factories under the Ministry of Electronics Industry (MEI), the Ministry of Chemical Industry (MCI), Shanghai municipality, and the Zhuhai Special Economic Zone also are undertaking silicon manufacturing projects. [redacted]

25X1

The Nonferrous Corporation

Despite a rocky start, CNNC now appears to have the leading role in silicon production. China's most ambitious silicon projects have been announced by CNNC. The Nonferrous Corporation's projects differ from the ones announced by other ministries in that each is characterized by a cooperative effort between a silicon research institute and a production unit (see table 2). [redacted]

25X1

[redacted] CNNC is now accepting bids on a feasibility study for expansion of the Luoyang Silicon Materials Plant, a project first announced in 1980. The project is being billed as either 50, 200, or 300 metric tons of additional capacity. The Chinese are considering the possibility of doubling capacity during the first five years of operation. [redacted]

25X1

25X1

The prospectus did not specify the polycrystalline production process to be used, and the feasibility study will outline the costs and benefits of the most advanced methods that could be used. The single-crystal furnaces sought by Luoyang managers are capable of producing state-of-the-art 100- to 150-mm wafers and are not normally exportable—even under revised US guidelines on sales to China—without modification. A portion of the wafers will be subjected to growth of an epitaxial layer of silicon. Since epitaxial wafers are used in the production of very-large-scale-integration (VLSI) integrated circuits, epitaxial reactors are also tightly controlled by both the United States and COCOM. [redacted]

25X1

[3] A 100-mm wafer can hold four or five times as many integrated circuit chips as a 50-mm wafer. Processing 200 chips on a single 100-mm wafer instead of on five separate 50-mm wafers substantially reduces the production cost of each chip. [redacted]

25X1

Table 1
China: Planned Silicon Projects

25X1

25X1

CNNC plans to set up another research facility at Zhejiang University. As one of the key projects of the Seventh Five-Year Plan (1986-1990), China will be setting up a chemical materials experimental center to "digest imported technology and equipment for processing new materials and recommend them to factories." Silicon is one of about two dozen materials the center will produce. Zhejiang University has apparently been selected as the site for the center.

25X1

Although the university is under the Chinese Academy of Sciences, equipment purchases for its Semiconductor Research Facility have been made by the trading arm of CNNC. The university reportedly has

25X1

Table 2
China: Research-Production Links in the Silicon Industry

Subordination	Institute	Factory
CNNC	General Research Institute for Nonferrous Metals (Beijing)	Luoyang Silicon Materials Plant (Luoyang, Henan)
CNNC	Semiconductor Research Facility at Zhejiang University (Hangzhou, Zhejiang)	Zhejiang Electronic Component and Materials Corporation (Hangzhou, Zhejiang)
CNNC/SITCO	Shanghai Nonferrous Metals Research Institute	Shanghai Second Metallurgical Plant

[redacted]

25X1

close ties to industry, and cooperates with CNNC's Zhejiang Electronic Component and Materials Corporation. The university purchased one semiautomated US furnace in September 1984, and has allocated space for an additional 10 furnaces. The research facility plans to conduct research on 150-mm ingots, in preparation for large-scale commercial production. If future furnaces all have the capability to grow 150-mm wafers, as envisioned by director Li Libun, plant capacity could be 50 metric tons of single-crystal ingot. [redacted]

25X1

[redacted]

25X1

Shanghai Municipality

[redacted]

25X1

[redacted]

During negotiations, SSMP engineers insisted on acquiring the most modern equipment possible, including waxless wafer polishers and automated crystal pullers.[4] [redacted] 25X1

[redacted]

[4] SSMP engineers, for example, expressed interest in the magnetic Czochralski and nonspiral drawing processes for growing crystals—extremely advanced methods used to improve purity levels to produce wafers for VLSI manufacture. (C NF NC) 25X1

[5] The furnaces will reportedly be exported with a 30-by-22-centimeter hot zone that will allow a maximum 18 kilogram charge size. The furnaces' sophisticated electronic control mechanism will remain intact, however, as the modification is a strictly mechanical one. The key element in a crystal furnace with up to 150-mm capability is its electronic control mechanism, and Chinese engineers have shown keen interest in it. [redacted]

25X1

25X1

Ministry of Electronics Industry

The MEI, China's principal producer of electronic devices, is expanding its silicon production capacity because some MEI officials believe the Luoyang plant and other non-MEI vendors cannot supply a reliable product. Other MEI officials have argued that Luoyang is too far away from the center of China's electronics industry to maintain its position as the country's leading silicon producer.

25X1

To meet its own demand for silicon, MEI has undertaken several smaller projects. China requested assistance from the United Nations Industrial Development Organization to modernize and expand an MEI silicon production facility in Zhejiang Province in 1981. Plans called for increasing polycrystalline silicon production at the Kaihua Factory from 4 to 15 metric tons per year, with single crystal output being increased from 1.5 to 6 metric tons per year. Although UNIDO did not fund this project, it apparently continues to be under consideration, as officials from the factory have discussed it with US businessmen as recently as October 1984.

25X1

In a separate project, officials of the Jiangnan Electronic Component Works in Wuxi, Jiangsu Province—one of China's most advanced manufacturing facilities for semiconductor devices—announced in mid-1984 their plans to expand silicon production. The plant has purchased at least three furnaces since 1982, and will probably purchase several more in the near future. In addition to supplying its own silicon requirements, the Wuxi plant reportedly plans to supply other Chinese electronics factories with silicon as well.

25X1

Others

Recently, Beijing Chemical Plant Number 2, subordinate to the Ministry of Chemical Industry (MCI), disclosed its plans to increase production to 200 metric tons of polycrystalline silicon and 70 to 100 metric tons of single-crystal silicon per year. Beijing Chemical Plant Number 2 plans to supplement its internal supply of polycrystalline silicon with material produced at the Shanghai Quartz Glass Factory, also under MCI, which announced its own expansion plans. Shanghai plant officials plan to triple capacity at the Quartz Glass Factory to produce 75 metric tons per year.

25X1

The Zhuhai Everbright Industrial Estate, a joint venture between the Zhuhai Special Economic Zone in Guangdong Province and the Chinese-backed Everbright Industrial Company of Hong Kong, also has announced its entry into China's silicon industry, with plans to produce 16 to 20 metric tons of single-crystal ingot a year.

25X1

Making It Work

We estimate that China will have the capacity to produce about 640 metric tons of polycrystalline silicon in 1990, slightly more than double its 1984 capacity. China's ability to process the polycrystalline material will develop more slowly at first, but we estimate that China should be able to process most of its annual output of polycrystalline silicon into wafers by the end of this decade (see figure 2).

25X1

In our judgment, China's efforts to expand silicon production will be on a more modest scale than the sum of all projects announced. As negotiations for

Figure 2
China: Estimated Silicon Capacity and Usage, 1984-90

25X1

304491 1-85

individual contracts advance, we expect some projects to be dropped and others to be scaled back. We believe, further, that those projects undertaken will probably be slower to start up than government planners and factory managers expect. There are a number of reasons.

No Central Authority

In our judgment, China's silicon expansion effort will suffer from a lack of a clear, coordinated plan and implementing structure. A central body charged with

25X1

overseeing the expansion has been, we believe, essential to China's successes in the research and production of some other strategic materials and technologies, such as fiber optics and the supercomputer. Since its formation, the Nonferrous Corporation has succeeded in establishing some control over the silicon industry—both the national research center and the largest of the active projects are now under CNNC's jurisdiction—but we doubt CNNC's ability to implement projects on the scale it is now considering. Luoyang's apparent need for loans, export credits, foreign investment, compensation trade, or cooperative production arrangements to fund expansion supports our belief that CNNC's premier plant may have difficulty gaining access to the foreign exchange required for its most ambitious expansion plans. Furthermore, a significant percentage of China's silicon production remains outside CNNC's control. [redacted]

25X1

Duplication

Because the expansion plans have not been coordinated, some duplication of effort is probable. We believe that expansion of polycrystalline silicon production at the Nonferrous Corporation's plant in Luoyang could cause the Ministry of Chemical Industry to scale back its plans for Beijing Chemical Plant Number 2. Agreement on the Nonferrous Corporation's Shanghai and Zhejiang University single-crystal silicon projects will probably lead the corporation to opt for a more modest effort at Luoyang, as available information indicates that the Shanghai and Zhejiang facilities will be processing polycrystalline silicon produced at Luoyang. Because reported output targets for Luoyang continue to range from 50 to 600 metric tons of polycrystalline silicon per year—despite Western advice to CNNC to opt for the largest facility possible—it is evident that expansion plans remain fluid.

25X1 [redacted]

Technology Absorption Problems

[redacted]

[redacted]

25X1

Problems range from an insufficient number of people to translate the technical manuals provided with imported furnaces and an inability to obtain spare parts for reactors because of bureaucratic bottlenecks to difficulty maintaining a high level of purity in chemical inputs. Easier access to spare parts and technical information now that US export controls have been liberalized, and closer coordination between institutes and factories may ease the technology absorption process, but we expect problems with quality control, a shortage of spare parts, and an untrained work force to persist. [redacted]

25X1

Production Delays

[redacted]

25X1

Implications

We believe China will have a substantial excess of polycrystalline silicon through 1989, which China's foreign exchange-hungry trading corporations and factories will aggressively seek to export (see figure 2). After 1989, China will probably have an excess of

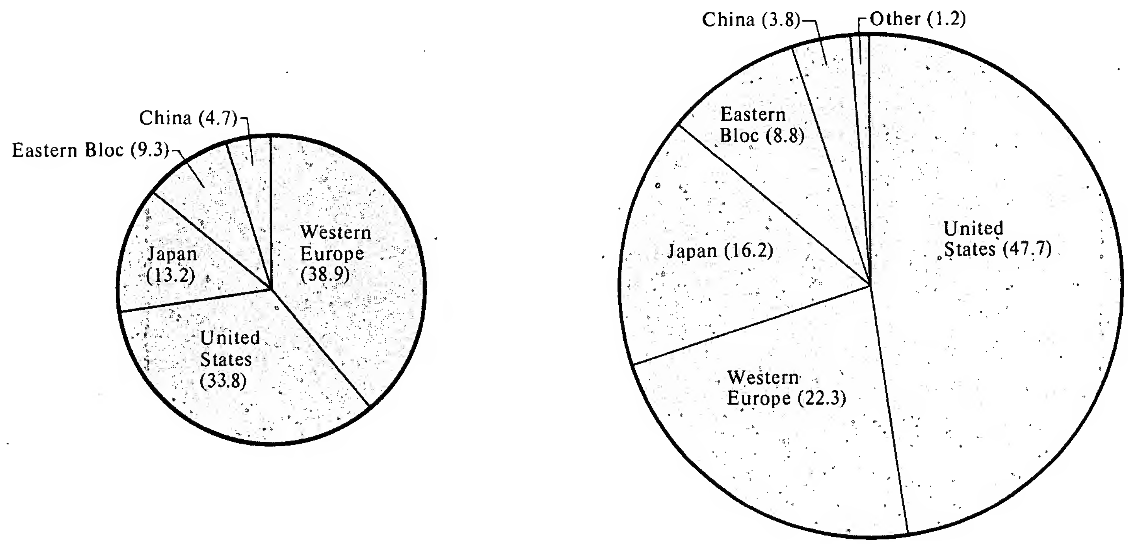
25X1

Figure 3
Estimated Polycrystalline Silicon Capacity, Worldwide, 1984 and 1990

Percent

1984
Total: 6,420 metric tons

1990
Total: 17,010 metric tons



Confidential

25X1

304492 1-85

single-crystal silicon ingots and wafers for a few more years, while the country's integrated circuit and electronic device fabrication capability—which requires dozens of different pieces of sophisticated equipment for each production line—develops.

25X1

The difficulty Beijing will have matching wafers of a certain diameter and purity with those required for its electronics sector will add to the problem of excess silicon. Like more experienced wafer manufacturers, China has difficulty allocating its capacity appropriately between a range of diameter sizes, crystal orientations, crystal-growing processes, and treatments for the wafer surface. Last year, for example, some Chinese corporations were offering 100-mm wafers for sale in international markets, while Chinese electronics factories short of 100-mm wafers imported them from materials brokers in Japan, the United States, and Europe. The Nonferrous Corporation's problems matching its supply with the Electronics Ministry's demand will probably persist. Chinese planners have indicated that small factories will continue to produce small-diameter wafers even as 125-mm wafer production begins in new facilities. This will increase the range of wafers available and worsen the problem of rational distribution (see figure 3).

25X1

Sanitized Copy Approved for Release 2010/01/20 : CIA-RDP86T00590R000100030003-9

In our judgment, excess Chinese polycrystalline and single-crystal silicon will probably continue to be exported primarily to non-Communist customers. Since 1981, Chinese corporations have sold an estimated 25 to 80 metric tons of polycrystalline silicon per year to materials brokers in the United States, Japan, and Europe. China began to offer modest amounts of 50-mm and 75-mm silicon wafers to European customers in 1982. Japan is chronically short of polycrystalline silicon, and purchases large quantities from Western Europe, which has an overabundance of the material. Because producing polycrystalline silicon is energy-intensive, Japan will probably continue to import some of the polycrystalline material it processes into wafers. Because of its proximity, China could be an attractive new source of supply. [redacted]

25X1

China's expanded silicon production will also add to the supplies of silicon potentially available to the Soviet Union and Eastern Bloc countries from non-COCOM suppliers. Since COCOM restrictions were placed on the export of silicon to Eastern Bloc countries after the invasion of Afghanistan in 1980, the Soviets have apparently targeted non-COCOM producers for silicon supplies. China and India (which has just announced a major new silicon project) are potential suppliers.[6] [redacted]

25X1

Although we believe the Chinese leadership would not authorize the sale of materials that could enhance Soviet military capabilities, Chinese silicon could be transferred by third-party brokers to the Soviets without the knowledge of central authorities. For example, China has sporadically sold silicon and other
25X1 semiconductor materials to a [redacted] chemical trading company [redacted] known to supply the Soviet Union.
25X1 Although there is as yet no evidence that Chinese silicon has been shipped to the Soviet Union, some Chinese gallium, arsenic, indium, and phosphorous
25X1 was probably shipped [redacted] to the USSR last March. To our knowledge, the Chinese were not aware that the Soviets were to be the recipients of their material. [redacted]

25X1

Nevertheless, sales of Chinese silicon to ready buyers [redacted] will probably increase with China's decentralization of foreign trade and with the implementation of recent directives requiring Chinese enterprises and corporations to operate at a profit. China does not have a central export control authority and has difficulty restricting its exports. [redacted] 25X1 Beijing's control is further hindered by the large and increasing number of Chinese trading corporations active in the sale of specific products and commodities. In the case of silicon, more than half a dozen entities are potential exporters (see table 3). [redacted] 25X1

US approaches to one or another exporter have so far proved ineffective in keeping Chinese silicon from being offered to the [redacted] broker. Demarches were made in September 1983 to the China Electronics Import and Export Corporation, a branch of MEI, and to the Chinese Ambassador to the United States. Objections apparently were also raised with the Nonferrous Corporation and the China National Instruments Import and Export Corporation (Instrimpex), a trading company under the Ministry of Foreign Economic Relations and Trade. The name of the [redacted] broker was not disclosed to the Chinese exporters. Although none of the entities have subsequently been observed offering silicon to the [redacted] broker, other Chinese firms are apparently entering the market and filling the gap. In April 1984, for instance, the China Scientific Instruments and Materials Corporation, which apparently operates directly under the State Science and Technology Commission (SSTC), offered silicon to COPCI. It is unclear whether silicon offers to COPCI have continued because Beijing is unable to control the exports of its many corporations, or because Chinese exporters have not been told which brokers to avoid. [redacted] 25X1

We believe that, for the next few years, Chinese silicon will continue to be offered occasionally to

25X1

[6] India's planned facility, to be undertaken with US assistance, will have an estimated 100 metric tons of excess capacity. [redacted]

25X1

Table 3

brokers who may retransfer it to Soviet Bloc countries. We judge there is little likelihood that this situation will change as long as:

- China has no central authority with responsibility for overseeing export controls.
- China's electronics industry is unable to absorb the increased silicon output.

25X1

25X1

Page Denied

Next 1 Page(s) In Document Denied